



Analysis and modification of the British Standard BS8006 for the design of piled embankments

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ABSTRACT

The piled embankment is an increasingly popular construction method. The Dutch Design Guideline for piled embankments (CUR 226) was published in the first half of 2010. Several existing models have been analysed to determine the calculation rules used in the Dutch Guideline. The British Standard BS8006 sometimes calculates tensile forces in the geosynthetic reinforcement that differ considerably from other models. For quite thin embankments in particular, BS8006 designs a relatively strong and thus expensive geosynthetic (basal) reinforcement in comparison with other design models. These differences are not always fully understood, leading to uncertainty. This paper analyses BS8006 and demonstrates why it behaves differently from other models. It also examines why this behaviour is different than would be expected. For example, it is shown that calculations using BS8006 are based on a higher load than the actual load.

A modification to BS8006 is proposed, which is shown to give comparable results to the German Standard EBGeo for situations where there is no subsoil support.

The results of BS8006, Modified BS8006, and the German/Dutch guideline are compared with finite element calculations and field measurements. It is concluded that the results given by the Modified BS8006 are more accurate to those using BS8006.

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1. Introduction

The piled embankment is an increasingly popular construction method. In the Netherlands for example, more than 20 piled embankments have been constructed during the last 10 years. Many more piled embankments have been reported in countries such as Germany, England, Scandinavia, the United States, Brazil, India, and Poland. The Dutch Design Guideline (CUR 226) was published in the first half of 2010 (CUR 226, 2010). This Guideline adopts major parts of the German Guideline EBGeo (2010). Several existing models have been analysed to determine the calculation rules used in the Dutch Guideline. The British Standard BS8006 sometimes calculates tensile forces in the geosynthetic basal reinforcement (GR) that differ considerably from other models. In the case of quite thin embankments in particular, BS8006 designs a relatively strong and thus expensive GR in comparison with other design models. These differences are not always fully understood leading to uncertainty. This paper analyses BS8006 and demonstrates why it behaves differently from other models. It

also shows why this behaviour is different than would be expected. A modification for BS8006 is proposed, referred to as the Modified BS8006.

The tensile force in the GR must first be calculated to design the GR in a piled embankment. The tensile force is caused by vertical load (traffic, soil weight) and by lateral load (active ground pressure due to outward horizontal thrust of the embankment). This paper only considers the tensile force calculations caused by the vertical loads in the system.

Section 2 of this paper thoroughly analyses BS8006 for reinforcement in piled embankments, and identifies its limitations. The resultant proposal for the Modified BS8006 is given in Section 3.

The final two sections compare the results of BS8006, the Modified BS8006, and the German/Dutch guidelines with finite element calculations and field measurements.

Safety philosophy is beyond the scope of this paper, and all safety factors in the calculation methods are therefore ignored. The paper focuses on the tensile force calculations caused by vertical loads in the piled embankment. Throughout the paper, pile spacing is assumed to be identical in both directions, except in Section 3.4. Here, equations for the Modified BS8006 are elaborated for the situation that $s_x \neq s_y$. Differences in GR stiffness J in both directions do not influence the equations.

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